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Influences of postfire salvage logging on forest birds in the Eastern Cascades, Oregon, USA

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ABSTRACT

In coniferous forests of western North American, fire is an important disturbance that influences the structure and composition of floral and faunal communities. The impacts of postfire management, including salvage logging and replanting, on these forests are not well known. We compared densities and relative abundances of forest birds after fire in unsalvaged stands and stands subjected to one of two intensities of salvage logging (moderate, 30 snags retained per ha and heavy, 5–6 snags retained per ha) in mixed-conifer forests in central Oregon. We used analysis of variance with repeated measures to evaluate three hypotheses concerning the influence of different intensities of salvage on densities or relative abundances of sixteen species of birds, and two hypotheses concerning the influence of time since salvage logging on relative abundances or densities of birds. We also examined the relationship between vegetation and abundances of each bird species. We did not detect significant differences among treatments in densities or relative abundances for eight species and one genus of birds. We detected significant differences for seven species, though the patterns differed among species. Relative abundances or densities of the black-backed woodpecker (*Picoides arcticus*), hairy woodpecker (*P. villosus*), brown creeper (*Certhia americana*), western wood-pewee (*Contopus sordidulus*) and yellow-rumped warbler (*Dendroica coronata*) were lower in the heavy and moderate salvage treatment compared to the unsalvaged treatment, while densities of the dark-eyed junco (*Junco hyemalis*) and fox sparrow (*Passerella iliaca*) were greater in the moderately and heavily salvaged stands than in the unsalvaged treatment. We detected significant differences between years for four species of birds. Our findings suggest that both cavity-nesting and cup-nesting species respond to salvage logging, and that some species respond uniquely to habitat features influenced by salvage logging. For species that responded negatively to salvage logging, the moderate salvage intensity did not appear to mitigate the negative influence of salvage logging. Areas of unlogged burned forest appear to provide important habitat for some species of birds following forest fires. Our findings parallel those of other recent studies of these species, suggesting robust patterns that transcend particular locations.

1. Introduction

Avian communities in postfire forests are unique (Rocky mountains: Hutto, 1995; Caton, 1996; Kotliar et al., 2002; Sierra Nevada: Bock and Lynch, 1970; boreal: Hobson and Schieck, 1999; Morissette et al., 2002; Schieck and Song, 2006). Cavity-nesting birds (Hutto, 1995; Saab and Dudley, 1998; Kotliar et al., 2002), aerial insectivores (Hutto, 1995; Caton, 1996; Kotliar et al., 2002), and ground- and shrub-foraging birds (Bock and Lynch, 1970; Caton, 1996) often increase in abundance following fire, and burned forests may be necessary for the persistence of some species of birds (Raphael and White, 1984; Raphael et al., 1987; Hutto, 1995; Murphy and Lehnhausen, 1998; Hobson and Schieck, 1999; Hoyt and Hannon, 2002). The abundance and characteristics of snags (Everett et al., 2000; Smith, 2000), abundance of insect prey (Muona and Rutanen, 1994; Rasmussen et al., 1996; McHugh et al., 2003), and characteristics of the forest floor and herbaceous and shrub communities (Kauffman, 1990; Agee, 1993; Smith, 2000) following stand-replacing fire are important habitat elements contributing to responses of wildlife to postfire conditions.

Although postfire forests provide habitat for many species, there often are competing management objectives in burned forests. Salvage logging, the removal of dead or dying trees from a landscape after a disturbance (Gorte, 1996), is often proposed or implemented to meet economic goals. Salvage logging directly or

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indirectly influences almost every aspect of postfire habitat that shape wildlife response (Karr et al., 2004; Donato et al., 2006; Lindenmayer and Ough, 2006; Russell et al., 2006), and as a result can profoundly influence presence and abundance of many species of wildlife.

A number of studies have examined the response of populations of birds to intensive postfire salvage that removes all or nearly all of the snags from an area (e.g., Saab and Dudley, 1998; Hutto and Gallo, 2006; Saab et al., 2007). Most of these studies have focused on cavity-nesting birds, although a few have examined the responses of the entire bird community to salvage logging (LeCoure et al., 2000; Morissette et al., 2002; Schwab et al., 2006). The influences of less intensive salvage activities on birds have received less study, and the responses of species to salvage intensity revealed in these studies has been variable. For example, the mountain bluebird (*Sialia currucoides*) and some woodpeckers (*Picoides* spp.) have greater densities or abundances in unsalvaged forests than in partially and completely salvaged forests in some studies (Saab and Dudley, 1998; Koivula and Schmiegelow, 2007; Saab et al., 2007), but greater numbers in partially salvaged forests than in unsalvaged or salvaged forests in another (Haggard and Gaines, 2001). Only two studies to date have evaluated the effects of different intensities of postfire salvage logging on cup-nesting birds (LeCoure et al., 2000; Schwab et al., 2006), both of which were conducted in boreal forests, and only one (Schwab et al., 2006) had a replicated study design.

Our objective was to determine differences in relative abundances or densities of birds in stands subjected to different intensities of salvage logging. We compared densities and relative abundance of birds among three treatments: unsalvaged, moderately salvaged (30 snags $\geq$35.6 cm DBH ha^{-1}), and heavily salvaged (5–6 snags $\geq$50.8 cm DBH ha^{-1}). We also examined the correlation of three vegetation variables with densities or relative abundances of each bird species in an attempt to better understand potential causal mechanisms responsible for differences in the response of some species.

2. Methods

2.1. Study area

We selected stands for study within the perimeter of an 8511 hectare (ha) fire that occurred on Davis Mountain, located just east of the crest of the Cascade Mountains in Deschutes County in Central Oregon. The pre-fire forest was composed primarily of ponderosa pine (*Pinus ponderosa*), with components of Douglas-fir (*Pseudotsuga menziesii*) and sugar pine (*P. lambertiana*). The stands also included lodgepole pine (*P. contorta*), white fir (*Abies concolor*), and Shasta red fir (*A. magnifica* var. *shastensis*), which were not typical species of historic forest conditions (USDA, 2004). Pre-fire land-use designations were matrix forest and late-successional reserves (LSR), as defined by the Northwest Forest Plan (USDA and USDI, 1994). The primary species of pre and postfire understory shrubs included snowbrush (*Ceanothus velutinus*), green-leaf manzanita (*Arcostaphylos patula*), and western chinquapin (*Castanopsis chrysophylla*). Pre-fire soils were comprised of a deep mantle of ash and pumice over an older layer of similar soil, and were characterized as highly permeable and well drained (USDA, 2004). Elevation ranged from 1350 to 2025 m and slopes were $\leq$25°.

The Davis Mountain fire occurred from late June through early July 2003. Within the fire perimeter, at least 95% tree mortality occurred within 75% of the burned forest. Prior to the beginning of our study, 2514 ha of the burned forest were salvage-logged between the fall of 2004 and early summer 2005. Three management prescriptions were implemented: unsalvaged, moderately salvaged, and heavily salvaged. Unsalvaged stands were located in LSR and no trees were removed from these sites. Within salvaged stands, all snags with a diameter at breast height (DBH) >91 cm were retained. Moderately salvaged stands were located in LSR and 30 snags $\geq$35.6 cm DBH ha^{-1} were retained. Heavily salvaged stands were located in lands designated as matrix, and 5–8 snags $\geq$50.8 cm DBH ha^{-1} were retained. Allocation of treatments to stands was completed by staff of the Deschutes National Forest prior to the beginning of our study.

2.2. Study stand selection

We restricted our selection of stands to those having similar aspect (90–180°) and elevation (1350–2025 m), moderate or high burn intensity, a density of $\geq$9 trees $\geq$91.4 cm DBH stand^{-1} prior to the fire, an area of at least 7 ha, and a shape allowing placement of at least three non-overlapping 80 m radius circles for bird sampling. Only four stands of each treatment met these criteria, and we used all of these as study stands (n = 12). Selected stands were located in areas of high burn intensity, dominated by standing dead trees (snags). The few live trees that were present in some sites were primarily along stand edges. Study stands ranged from 10 to 112 ha in size (unsalvaged stands: 10–18 ha, moderately salvaged stands: 20–112 ha, and heavily salvaged stands: 13–45 ha). We selected three points in each stand for bird sampling with each point separated by $\geq$160 m in all stands and $\geq$100 m from stand edges where possible. In stands of area >40 ha, we clustered the points to mimic the layout in smaller sized stands.

Salvage treatments were implemented prior to the beginning of our study. Secondary fuel treatments, to decrease the risk of future fire, occurred between out two field seasons in seven stands (all of the heavily salvaged stands and three of the moderately salvaged stands; one moderately salvaged stand did not warrant treatment because of little standing and on the ground fuel). Fuels treatments involved felling snags <20.3 cm DBH, cutting them into 4.3 m lengths. One moderate salvage stand was broadcast burned in the fall of 2005.

2.3. Vegetation sampling

We established four vegetation plots at each bird sampling point. One plot was centered on the bird sampling point and three satellite plots were located 30 m from the center point and radially spaced 120° from one another; the compass bearing of the first satellite point was randomly selected. Each vegetation plot consisted of nested 5 and 11.3 m radii circles. We modified the BBIRD vegetation protocols (Martin et al., 1997), and visually estimated the percent ground cover of grass, forbs, shrubs, downed wood ($\geq$10 cm in diameter), small wood (<10 cm in diameter), and bare soil within the 5 m radius circle. Within the 11.3 m radius circle, we measured DBH of all standing snags $\geq$10 cm DBH and $\geq$2 m tall. We tallied the number of snags <10 cm DBH and $\geq$2 m tall. We divided all snags into five DBH categories ($\leq$20, >21–35, >36–50, >51–90, and >91 cm) and examined the diameter distribution among treatments. We compared densities of snags >35 cm DBH among treatments and years; we selected this cut-off given the implemented salvage prescription and the preference of wildlife for large snags.

At each plot, we established two transects to measure volume of downed wood and shrubs. We established transects at bearings ±45° of the plot's aspect. Transects were 22.6 m long and intersected at their midpoints at the center of the vegetation plot. We identified and tallied all shrubs $\geq$0.25 m tall that intersected the transect for $\geq$0.05 m. We measured height, and maximum widths parallel and perpendicular to the transect for each shrub. We recorded a shrub twice if it intersected both transects. We calculated volume of shrubs as:

$$\text{Shrub volume} = \frac{4}{3}\pi\frac{w_1 w_2 h}{2}\ (\text{m}^3\ \text{ha}^{-1})$$